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Value of Fungicide Application in Wheat Production in Southwest Kansas

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Abstract

During the past several years, applying fungicide to wheat has become a more common practice. The availability of cost-effective generic fungicides, as well as the positive yield responses often reported, seem to be the potential drivers for the adoption of such practices by producers. We conducted a wheat fungicide trial in Garden City, KS, to answer the following questions: 1) Do fungicide applications pay? And 2) Can remote sensing technology be used to quantify the efficacy of different fungicide products? The study consisted of two wheat varieties sown on September 29, 2015 (Oakley CL, highly resistant to stripe rust; and TAM 11, highly susceptible to stripe rust), different fungicide products and different times of application. Stripe rust was the major fungal disease impacting wheat yield in southwest Kansas in 2015-16. Fungicide application increased grain yield over the control for all fungicide products. The greatest grain yield resulted from the application of Tebustar. These results suggest that there could be some potential benefits to early season application of fungicide in southwest Kansas, although the majority of the grain yield gain comes from the flag leaf application. Additional years of data are required to make more robust, meaningful interpretations.

Keywords

remote sensing, stripe rust, fungicide, wheat

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Summary

During the past several years, applying fungicide to wheat has become a more common practice. The availability of cost-effective generic fungicides, as well as the positive yield responses often reported, seem to be the potential drivers for the adoption of such practices by producers. We conducted a wheat fungicide trial in Garden City, KS, to answer the following questions: 1) Do fungicide applications pay? And 2) Can remote sensing technology be used to quantify the efficacy of different fungicide products? The study consisted of two wheat varieties sown on September 29, 2015 (Oakley CL, highly resistant to stripe rust; and TAM 11, highly susceptible to stripe rust), different fungicide products and different times of application. Stripe rust was the major fungal disease impacting wheat yield in southwest Kansas in 2015-16. Fungicide application increased grain yield over the control for all fungicide products. The greatest grain yield resulted from the application of Tebustar. These results suggest that there could be some potential benefits to early season application of fungicide in southwest Kansas, although the majority of the grain yield gain comes from the flag leaf application. Additional years of data are required to make more robust, meaningful interpretations.

Introduction

Wheat yield in southwest Kansas is highly dependent on weather conditions. In years like 2015 and 2016, when adequate moisture was available at the critical stages, such as grain filling, and cool temperatures occurred during heading and flowering, many fields had bumper wheat yields averaging over 100 bu/a. Moisture availability and temperature during the heading to grain filling stages are critical to producing high-yielding wheat. Unfortunately, we cannot order these conditions each year. However, there are some factors we can control, such as selecting varieties, providing adequate nutrition, and applying a foliar fungicide to protect yields in high-disease years. In recent years, with the availability of more affordable generic fungicides, producers are becoming interested in adopting this practice to protect grain yield from major fungal diseases. It is important for producers to be aware that application of fungicides protects yield potential that is present at the time of application. Fungicides serve as yield protectors by enhancing the plant health. Therefore, it is not uncommon for producers to associate delayed harvest with fungicide application. Fungicides allow plants to stay green and keep their leaves longer, using more nutrients during the late development stages.

Previous research has reported variable results regarding the value of fungicide application in the Great Plains. In Kansas, several years of research have indicated that a single fungicide application to a susceptible variety, on average, could provide a 10% yield increase relative to the untreated control. To maximize the benefit of a fungicide application, producers should know the vulnerability of the variety to be treated. Susceptible varieties are more likely to provide a yield benefit compared to a variety with a moderate to high level of resistance. It is also important to pay attention to weather conditions and scouting reports within a field, a region, and even surrounding states to the south.

Rating the effectiveness of a foliar fungicide application on disease control is often tedious and very subjective. With the onset of remote sensing technology, there are great opportunities to develop more objective approaches for rating varietal resistance to diseases and the efficacy of fungicides. Measurements such as the normalized difference vegetation index (NDVI), which combines wavebands in the red region of the spectrum that is controlled by the leaf pigment content, and wavebands in near-infared region of the spectrum that is controlled by the leaf internal structures is strongly correlated with plant health. Application of fungicide is reported to enhance plant health that results in the plant staying green longer. Therefore, differences in NDVI before and after fungicide application relative to the control could be used to develop a more objective scale for rating fungicide efficacy.

The objectives of this study were to evaluate the value of variety selection and application of a fungicide as part of an economically optimal foliar disease management plan and to access the potential for using remote sensing measurements such as NDVI as a tool for rating fungicide efficacy.

Experimental Procedures

An experiment was established at the Southwest Research-Extension Center in Garden City, KS, in fall 2015. The design of the experiment was a randomized complete block design with three replications consisting of eleven fungicide application treatments and two wheat varieties: Oakley CL (highly resistant to stripe rust) and TAM 111 (highly susceptible to stripe rust). The experimental treatments are summarized in Table 1. The plots were seeded on September 29, 2015, at a seeding rate of 240 lb/a. The seeding rate was twice the recommended rate for irrigated wheat. This was a result of a problem with the drill, the plots were planted twice at the recommended 120 lb/a. The plots were 7.5-ft × 30-ft. The plots were fertilized with 100 lb of N at green up in March of 2016 and were sprayed with a mixture of 0.4 pint of Starane, 0.375 quart of MCPA, and 0.1 oz of Ally the first week of April for weed control. Fungicides were applied at 15 GPA with a CO_2 backpack sprayer when the flag leaf was fully emerged and the ligule was visible (Feekes, GS 9). A plot combine 5 ft wide was used to harvest 25 ft from each plot for yield. Subsample was collected from each plot to determine the test weight and moisture content. Yield was adjusted to 13% moisture.

The normalized difference vegetation index (NDVI) was collected before and 30 days after the flag leaf fungicide application. A handheld Greenseeker (Ntech Industries, Inc, Ukiah, CA) sensor was used to measure the NDVI. The difference between the before and after NDVI values were used to assess the efficacy of the fungicide.

Results and Discussion

Timely rainfall events and cool temperature during flowering to grain fill (Table 2) could best describe the climatic condition for the 2015-16 wheat growing season in southwest Kansas. Compared to the 30-year average, the studied season was warmer and wetter in the fall months, drier and warmer in the winter months, wetter and warmer in April, drier but warmer in May, but wetter and cooler in June (Table 2). These conditions, coupled with good management, were conducive for producing the highest wheat yield for many farms in the southwest region. The wet June and July months were the only problem that led to a delay in harvest and lower test weight.

The result of our study showed that fungicide application was a good investment to maximize yield under these very good growing conditions for the susceptible variety. All fungicide treatments increased grain yield over the control for TAM 111 (Table 3), while fungicide seems to have no impact on yield for Oakley CL (Table 3). The Oakley CL lodged 100% in all plots, which significantly affected the yield and test weight. TAM 111 yield was significantly higher from the early spring application of Priaxor, and the combined application of Aproach and Aproach prima, Prosaro, Twinline, and Tebustar. Fall application of Priaxor at 2 and 4 oz rates and Absolute Maxx also increased yield, but were not significantly different from the control (Table 3). Likewise, the change in the NDVI was not a function of foliar fungicide for the variety Oakley CL, but was for TAM 111. The degree of change in NDVI 30 days after application to TAM 111 offers insight on the effectiveness of the fungicide on the disease control. The NDVI in the untreated plot decreased by 0.07 for TAM 111, compared to 0.01 for the same variety treated with foliar fungicides TebuStar and Twinline, 0.02 for Absolute Maxx, Prosaro, and combined application of Aproach and Aproach Prima and 0.03 for Aproach Prima (Table 3). Table 4 shows a negative return on investment (ROI) when fungicide was added to Oakley CL, but showed positive ROI when fungicide was added to the TAM 111. The negative effect of the fungicide on yield and ROI of Oakley CL should not be interpreted as the fungicide hurting yield, but should be seen more as the fungicide not having a positive yield benefit on the resistant variety. Other variables such as lodging were also contributing factors to yield response observed for the Oakley CL variety. The greatest return on investment was achieved when the generic Tebustar was used. Returns were calculated assuming a wheat price of $3.00 per bushel.

Conclusion

Cool, wet climatic conditions are conducive for high wheat yield, but to maximize yield in these conditions applying a fungicide to a susceptible wheat variety is a good decision. The generic fungicide was one of the top performers. Fungicide application was not a good decision on the more resistant variety Oakley CL. In general, flag leaf application was the most profitable, even though early spring application of Priaxor did show positive return on investment.

Change in NDVI before and after fungicide application was greater for the untreated TAM 111 compared to the fungicide treated and untreated Oakley CL. The result showed that the use of NDVI measurement could be used as a potential tool for accessing fungicide efficacy. However, more work is needed in this area to develop a protocol for using such measurements.

Oakley CL is a better dryland variety than irrigated, and planting at the extremely high population that we did in this study under irrigation might have contributed to the lower yields observed for the variety due to increased lodging. However, the high population provided a good environment for the disease and disease control. Planting Oakley CL at much lower population (approximately 60 lb/a) could possibly reduce lodging and improve the variety performance under irrigation.

Table 1. Fungicide rate, time and growth stage of application for each treatment

Treatment	Product	Time of application	Product rate	Stage of application	Date applied	Growth stage (GS)
1	Control	NA	NA	NA	NA	NA
2	Priaxor	Fall	2 fl oz	3 Leaf	October 27	Feekes, GS 2
3	Priaxor	Fall	4 fl oz	3 Leaf	October 27	Feekes, GS 2
4	Priaxor	Spring	2 fl oz	Green up	March 21	Feekes, GS 5
5	Priaxor	Fall	2 fl oz	3 Leaf	October 27	Feekes, GS 2
5	Priaxor	Spring	2 fl oz	Jointing	April 7	Feekes, GS 7
6	Aproach	Spring	3 fl oz	Jointing	April 7	Feekes, GS 7
6	Aproach Prima	Spring	6.8 fl oz	Flag leaf	April 25	Feekes, GS 9
7	Aproach Prima	Spring	6.8 fl oz	Flag leaf	April 25	Feekes, GS 9
8	Tebustar	Spring	4 fl oz	Flag leaf	April 25	Feekes, GS 9
9	Prosaro	Spring	6.5 fl oz	Flag leaf	April 25	Feekes, GS 9
10	Absolute Maxx	Spring	5 fl oz	Flag leaf	April 25	Feekes, GS 9
11	Twinline	Spring	9 fl oz	Flag leaf	April 25	Feekes, GS 9

NA- Not applicable.

Table 2. Precipitation and temperature data for the 2015-2016 wheat growing season at the Southwest Research–Extension Center, Garden City, KS

	Average temperature		Rainfall (in.)	
Month	2015-2016	30-year average*	2015-2016	30-year average
September	60	68	0.03	1.42
October	62	55	2.52	1.21
November	71	42	0.85	0.55
December	69	31	1.14	0.59
January	70	30	0.03	0.46
February	53	34	0.27	0.55
March	48	43	0.04	1.31
April	62	52	4.73	1.74
May	66	63	1.05	2.98
June	61	73	3.96	3.12
July	67	78	5.79	2.8
Annual	63	52	20.41	16.73

* The 30-year averages are for the period 1985-2014.

Table 3. Wheat yield, test weight, and normalized difference vegetation index (NDVI) measured before and after fungicide application, and the difference in NDVI based on the fungicide treatments and wheat variety

	Yield (bu/a)		Test weight (g)		NDVI_B		NDVI_A		NDVI_diff	
Treatments	TAM	OAK	TAM	OAK	TAM	OAK	TAM	OAK	TAM	OAK
Check	82	81	55	55	0.901	0.898	0.832	0.856	-0.07	-0.04
Prixaor (F)	86	84	56	55	0.893	0.899	0.821	0.851	-0.07	-0.05
Priaxor (F)	97	73	56	55	0.882	0.878	0.83	0.857	-0.05	-0.02
Priaxor (S)	109	62	56	55	0.883	0.896	0.844	0.856	-0.04	-0.04
Priaxor (F/S)	106	71	57	55	0.866	0.891	0.825	0.855	-0.04	-0.04
Aproach/ Aproach Prima	103	79	57	55	0.88	0.888	0.86	0.862	-0.02	-0.03
Aproach Prima	96	71	56	55	0.894	0.897	0.86	0.857	-0.03	-0.04
Tebustar	112	68	58	54	0.86	0.898	0.846	0.858	-0.01	-0.04
Prosaro	106	78	57	55	0.883	0.901	0.864	0.853	-0.02	-0.05
Absolute Maxx	97	75	57	55	0.887	0.899	0.868	0.853	-0.02	-0.05
Twinline	108	65	57	54.4	0.86	0.895	0.85	0.857	-0.01	-0.04
$LSD_{0.05}$	21	20	1.33	1.34	0.029	0.02	0.032	0.02	0.03	0.03
CV	14	16	1.79	1.43	2.04	1.42	2.60	1.85		

NDVI_ B: measurement taken before fungicide application, NDVI_A: measurement taken 30 days after fungicide application.
LSD = least significant difference.
CV = coefficient of variation.
TAM = TAM 111.
OAK = Oakley CL.

Table 4. Net return on investment for different fungicide treatments on Oakley CL and TAM 111 wheat varieties for the 2015-2016 growing season

Treatments	Cost of fungicide	Cost of application	Total cost of treatment	Yield (bu/a)		Value of production		Added return to treatment		Net return to treatment		Value of production treatment cost	
				TAM	OAK	TAM	OAK	TAM	OAK	TAM	OAK	TAM	OAK
Control	0.00	0.00	0.00	82	81	246.00	242.01	0.00	0.00	0.00	0.00	246.00	242.01
Priaxor (F)	9.60	6.50	16.10	86	84	258.00	251.01	12.00	9.00	(4.10)	(7.10)	241.90	234.91
Priaxor (F)	19.21	6.50	25.71	97	73	291.00	219.99	45.00	(22.02)	19.29	(47.73)	265.29	194.28
Priaxor (S)	9.60	6.50	16.10	109	62	327.00	185.01	81.00	(57.00)	64.90	(73.10)	310.90	168.91
Priaxor (F/S)	19.21	13.00	32.21	106	71	318.00	213.99	72.00	(28.02)	39.79	(60.23)	285.79	181.78
Aproach/Aproach Prima	23.98	13.00	30.48	103	79	309.00	236.01	63.00	(6.00)	26.02	(36.48)	272.02	205.53
Aproach Prima	17.00	6.50	23.50	96	71	288.00	213.00	42.00	(29.01)	18.50	(52.51)	264.50	189.50
Tebustar	1.34	6.50	7.84	112	68	336.00	203.01	90.00	(39.00)	82.16	(46.84)	328.16	195.17
Prosaro	14.79	6.50	21.29	106	78	318.00	234.00	72.00	(8.01)	50.71	(29.30)	296.71	212.71
Absolute Maxx	10.64	6.50	17.14	97	75	291.00	225.99	45.00	(16.02)	27.86	(33.16)	273.86	208.85
Twinline	16.09	6.50	22.59	108	65	324.00	195.99	78.00	(46.02)	55.41	(68.61)	301.41	173.40

(#), Negative return to treatment.
TAM = TAM 111.
OAK = Oakley CL.